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## POLICY MEASURES AND INSTITUTIONS FOR IMPROVED FOREST CONSERVATION, MANAGEMENT AND DEVELOPMENT IN AFRICA

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## FOREWORD

This study was prepared by the Economic Commission for Africa (ECA), in response to the request of the countries of the African subregion, expressed by the eleventh meeting of the Conference of Ministers held in Addis Ababa in May 1985, and subsequently approved by the United Nations General Assembly in the same year.

The assignment was carried out by the Joint ECA/FAO Agriculture Division under its 1986-1987 work programme, programme element 1.4 "Improved policies and programmes for conservation and development of forest and land resources". This document is based on a paper prepared by two consultants and was reviewed by the Forestry Department of FAO, Rome.

Note

Tables and boundaries of the countries covered by this study do not imply the expression of any opinion whatsoever on the part of the Economic Commission for Africa or of the United Nations, concerning delimitation of their boundaries, the legal status of each country or area of its authority.

# I. INTRODUCTION

1. The purpose of this study which is in accordance with ECA's 1986 work programme is to review the current state of land use and forest conservation practices and, where required, recommend appropriate policy framework for the development and conservation of the forest resources in Africa, using the miombo case. This forest formation, which occupies an estimated area of 190 million ha, covering vast areas of seven countries south of the equator, is disappearing at a rate of about 200,000 ha per year. The paper deals with the main causes that prevent the normal development and conservation of the miombo forest resources in three African countries and describes the main silvicultural farming systems used in these countries as a case study. After reviewing and appraising present forestry policies and legislation, the paper concludes by recommending areas of action and investment to conserve this important ecosystem in space and time.

2. In Africa "miombo" forests 1/ are found mainly south of the equator, and in Eastern Africa cover the largest area of natural forest land. Unfortunately, this forest resource has been overexploited for decades for wood products, agriculture and other human activities which have had destructive effects (e.g., bush, grass and forest fires). The ecology and balance is therefore precarious. It is against this background that the Lagos Plan of Action stressed three major objectives, namely:

(a) The expansion by 10 per cent per year up to 1985, of areas to be regenerated such as the miombo woodlands;

(b) The expansion by 10 per cent of the forest estate between the years 1980 and 1985 (the majority of the unreserved forests are in the miombo woodlands);

(c) Progressive prohibition of log export with a view to achieving a 50 per cent reduction between 1980 and 1985.

Although the existing legislation prohibits it, logs are still being exported, partly to reduce the foreign exchange problem. Typical species include Dalbergia melanoxylon and Swartzia madagascariensis.

3. This issue was stressed in OAU's document Africa's Priority Programme for Economic Recovery, 1986-1990 (APPER). The Programme gives particular emphasis to a "systematic campaign against destruction of forest heritage", and calls for an appropriate policy for the management of these natural resources. The ECA paper on "Problems and prospects for the harmonization of forest development policies in Africa (1985)", also expresses concern about the misuse of the natural resources, and FAO's Tropical Forestry Action Plan (considered to be a most practical programme for arresting forest degradation) also includes programmes for the rehabilitation of these resources.

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1/ Open forest formations with abundant Brachystegia and Julbernardia spp.

The miombo woodlands mission

4. In September 1986, the United Nations Economic Commission for Africa, in co-operation with the Food and Agriculture Organization of the United Nations, launched a study of the miombo woodlands as part of its 1986-1987 work programme. The main objectives of the study were to examine present land use and wood production, assess the causes and magnitude of the depletion of the woodlands and suggest measures to be taken at national and subregional levels.

5. The study concentrated on Mozambique, the United Republic of Tanzania and Zambia. The findings of the mission are therefore based principally on these three countries. The thrust of this study deals with the identification and harmonization of forest and other national policies that could reverse the present tendency of degradation and depletion of the miombo woodlands. The implementation of the recommendations of this study will require the allocation of increased resources for the development of the miombo forest resources, at national and subregional levels.

## II. THE MIOMBO WOODLANDS RESOURCE

6. The miombo woodlands in the subregion are a two-storeyed, semi-deciduous forest formations open to lightly closed canopy. This forest formation is dominated by species of Brachystegia, Isoberlinia and Julbernardia, in association with Uapaca, Parinari and Pterocarpus. The understorey is characterized by Albizia, Diospyros and Dalbergia species. The occurrence of these species depends on the type of soil, amount and reliability of rainfall, the intensities and frequency of fires, etc. The woodlands occur from zero to 2,000 metres or more above sea level and have an average annual rainfall of 500-1,600 mm. In Mozambique, Brachystegia dominates the central and northern regions, with the Limpopo river as its southern limit. Both Brachystegia and Julbernardia occupy about 70 per cent of the land area in Mozambique. In Tanzania, where the miombo stands are found from zero to 1,600 m altitude, with rainfall between 500 and 1,200 millimetres per annum, Brachystegia spiciformis associated with deciduous Julbernardia are the most valuable timber species. In Zambia, the miombo woodlands occur on the main plateau, and in addition to the two species already mentioned, Isoberlinia and Marqueria spp. are also dominant.

The distribution of miombo woodlands

7. These woodlands cover an estimated area of 109 million ha in the subregion, distributed as follows (see also maps 1, 2 and 3): Mozambique, 37 million ha; Tanzania, 44 million ha; and Zambia, 28 million ha. These forests represent 94, 90 and 75 per cent of the total indigenous forests of the three countries respectively, including national parks, game reserves and controlled areas which occur or are associated with miombo woodlands respectively, and their distribution by altitude is given in tables 1(A) and 1(B) below.

Table 1 A. Distribution of miombo woodlands by altitude in the United Republic of Tanzania a/

| Altitude above sea level metres | Forest reserves | Unreserved forest | Total | Unreserved forest Percentage |
|---|---|---|---|---|
| | (millions of hectares) | | | |
| 0 - 500 | 8.8 | 11.5 | 20.3 | 57 |
| 501 - 1 000 | 3.1 | 10.5 | 13.6 | 77 |
| 1 001 - 2 000 | 1.2 | 3.1 | 4.3 | 72 |
| 2 001 and above | 0.3 | 2.0 | 2.3 | 87 |
| Total | 13.4 | 27.1 | 40.5 | 67 |

a/ Excludes some estimated 6 million ha in national parks, game reserves and game controlled areas.

Table 1 B. Distribution of miombo woodlands by altitude in Mozambique

| Altitude above sea level (metres) | Area (millions of hectares) | Total miombo woodlands (percentage) |
|---|---|---|
| 0 - 500 | 27.1 | 72 |
| 501 - 1 000 | 8.2 | 23 |
| 1 001 and above | 2.2 | 5 |
| Total | 37.5 | 100 |

Note: Classification of reserved and unreserved forests was not available. Figures are based on calculations from altitude and vegetation maps made by the ECA consultancy, September 1986.

8. The estimated average gross volumes for trees with Dbh >25 cm (the diameter at 1.30 m above ground level) are 30, 35 and 38 cubic metres per ha for Mozambique, the United Republic of Tanzania and Zambia respectively. The total standing volume in each country is shown in table 2 below. It is estimated that about 40 per cent of total volume of the miombo wood is mainly canopy, which can be utilized as fuelwood.

Table 2. Esimated growing stock of miombo by countries

| Country | Area millions of hectares | Volume millions of cubic metres |
|---|---|---|
| Mozambique | 19.0 | 570 |
| United Republic of Tanzania | 36.8 | 1 288 |
| Zambia | 24.9 | 946 |
| Total for the subregion | 80.7 | 2 804 |

Source: ECA mission, September 1986.

9. This estimate of the miombo stands is of limited tenability due to lack of accurate and frequent inventories in the countries studied. In Mozambique for example, a preliminary inventory was carried out in 1979-1981, but only covered part of the Niassa Province where there were plans to build a sawmill and sleepers factory. The total inventoried area was 1.5 million ha. Another inventory was carried out in the Cabo Delgado Province, covering an area of 0.6 million ha. In the United Republic of Tanzania, an inventory was carried out in 1971-1973 in the Handeni, Lindi, Kilombero and Tabora blocks, covering 7.04 million ha. This represented only 19 per cent of the total productive miombo forests. The Zambia miombo woodlands have not been inventoried for quite some time, but this is planned.

10. In addition, there are important non-wood resources which at times contribute more significantly to the well-being of the local communities and national economies. These include food for livestock, and wildlife products, honey and beeswax, etc.

## III. CURRENT LAND-USE AND CONSERVATION PRACTICES

11. Land use and conservation in the miombo woodlands is affected by four major constraints, namely, population pressure, fragile ecosystem (especially poor, infertile soils), constant fires and hunting which has endangered some wildlife species. In the United Republic of Tanzania 6 million-7 million people live in miombo woodlands (33.2 per cent of total population). The figures for Mozambique and Zambia are 66.7 and 29.3 per cent respectively. Population pressure and shifting cultivation in many areas have accelerated the degradation and depletion of this woodland forest resource. Although accurate rates of miombo disappearance are not available, it is estimated that more than 150,000 ha are deforested each year in the subregion.

### Farming systems

12. There are three dominant farming practices in the subregion: (a) subsistence shifting cultivation, with or without livestock; (b) subsistence farming, including cash crop, with or without livestock; and (c) permanent agriculture including agro-forestry, in the almost-depleted miombo areas. In order to focus on the critical areas, the following analysis

will concentrate on only a few farming systems, namely, the "Chitemene" shifting cultivation in northern Zambia; "tobacco farming" in Tabora region in Tanzania; and the "cotton-food" crop shifting cultivation in northern Mozambique.

"Chitemene" shifting cultivation

13. This system is practised mainly in the northern and Luapula provinces of Zambia, where soils are generally poor and acidic. The major crops planted are finger millets, sorghum and cassava. The secondary crops include maize, beans and ground-nuts. The system involves the cutting of bush and lopping of tree branches. These depend on vegetation size and type, heaped into circles ranging from 200 to 300 m in diameter. This is done during the dry season (May/June - September). The piles are burnt at the onset of the rainy season, and the crops are then planted. Millet is harvested during the following dry season and in the subsequent planting seasons, beans and ground-nuts are introduced. It is interesting to note that Zambia grows tobacco in the eastern and central provinces in the miombo area, but little shifting cultivation is practised by the small farmers.

14. There is now a tendency by farmers to plant maize partly as a cash crop. Therefore, the "Chitemene" system is progressively changing towards more permanent cultivation. The system still has several inherent problems. Firstly, it greatly reduces the miombo cover because farmers cut whole trees rather than just lopping them. Additional trees outside the "Chitemene" are cut and used as fences to protect crops from marauding animals. Secondly, this practice cannot cope with the demands for land of the rapidly increasing population (the annual rate now being 3.7 per cent in Zambia, 2.93 per cent in Mozambique and 3.07 per cent in the United Republic of Tanzania). According to the experts, about 40 ha of forest land are needed per person (220 ha per family) to sustain the system. Thirdly, it reduces fallow periods, particularly near the homesteads which do not involve long walking distances. Fourthly, the long-term effects of this system on the soils of the miombo ecosystem are still unknown.

15. However, this system undoubtedly has some short-term advantages. It reduces farm inputs such as fertilizer, and it increases crop production for the first few years.

Tobacco farming in Tabora region

16. This is essentially a tobacco-food crop farming system practised by over 350,000 farmers in the Tabora region. Tobacco is the principal cash crop while the food crops include maize, sorghum, cassava and ground-nuts. Maize and ground-nuts are progressively becoming semi-cash crops, especially for the local markets. Tobacco farming is still a shifting cultivation system because:

(a) The soils are relatively poor in nutrients and humus;

(b) Most of the tobacco growing areas are infected with nematodes, and this, jointly with the lack of pesticides, has so far hindered the cultivation as a permanent form of agriculture;

(c) In order to cultivate tobacco, farmers clear miombo stands on a massive scale. Thus the supply of firewood for curing the tobacco decreases and the farmer "follows" the wood and moves on to and clears another area;

(d) Tobacco farming is very labour-intensive and requires the efforts of the whole household. Farmers therefore tend to concentrate their activities where labour is available;

(e) Lack of capital prevents most farmers from having permanent "modern" barns for curing tobacco. This would involve high transport costs for the green tobacco leaves and fuelwood.

17. The total area under tobacco cultivation in the United Republic of Tanzania is about 40,000 ha, half of which is cultivated in Tabora Province, which produces 20 million kg per annum and production per ha ranges from 350 to 600 kg/ha. About 100 kg of wood is to cure 1 kg of tobacco or 450 kg of tobacco needs 50-60 $m^3$ of solid wood. In other words, tobacco from one hectare requires approximately the roundwood of a hectare of miombo stands. Therefore, to cure Tabora's tobacco production of 20 million kg, it requires about 2.2 million $m^3$ of miombo wood. The figure for Tanzania as a whole (with a potential tobacco production of 50 million kg) is 5.5 million $m^3$ of wood. This is the main cause of deforestation. In Zambia and Mozambique, the average yield of tobacco per ha was 1,130 and 1,111 kg respectively in 1984.

18. Moreover, as this wood is often obtained free (except for the labour required for felling and burning the trees), it is evident that these forests are heavily subsidizing the tobacco industry. Unless an effective investment programme for afforestation is rapidly carried out, the tobacco industry will have to cease its activities for lack of firewood. Eventually, although preliminary studies on other sources of energy have been carried out, particularly on coal, it has been realized that the Tabora region could not take advantage of this source of energy because of the distance between Tabora and the coal mines which are in the south-west (Mbeya region) and the prohibitive transport costs involved. However, other tobacco-growing areas like Iringa, Mbeya and Ruvuma should look more seriously into this possibility, as well as exploring other sources of energy.

19. It has been reported that in the United Republic of Tanzania the miombo stands support about 36 per cent of the total livestock, mainly cattle, in the country. This figure seems to be unrealistic because it includes areas where the miombo woodlands are almost depleted. Moreover, tsetse fly (Glossina morsitans) is still a serious problem in 60 per cent of the miombo areas in the United Republic of Tanzania and constitutes a serious problem not only for the management of miombo forests, but also for the exploitation of wildlife and livestock of these zones. Livestock is mainly exploited in the eastern districts of Igunga and Nzega where the tsetse fly problem is less acute.

The cotton-food crop shifting cultivation system

20. This is mostly confined to northern Mozambique. The food crops include sorghum, finger millets and cassava and once again the poor quality of the soils and lack of fertilizers have helped to sustain this shifting cultivation system. This and other types of agriculture practices have substantially contributed to the loss of 15,000 ha per annum of forests, which have passed to agriculture.

Permanent agriculture under former miombo formations

21. This is predominant in the most depleted miombo woodlands. The main practice is mixed farming including livestock production. Agro-forestry, tree-growing and the use of fertilizer and manure are common. The study revealed some general trends in the subregion as follows.

22. There is a marked shift from purely subsistence-shifting cultivation to cash cropping: for example, increased maize cultivation by the small farmers in both Tanzania and Zambia and cotton cultivation in northern Mozambique. If some inputs like fertilizers were economically available, this shift would probably proceed faster than at present. According to the Forest Department in Zambia the price of a kilogram increased from 1.08 kwachas 2/ in 1985 to 3.2 kwachas in 1986 (representing an increase of 196 per cent). In the United Republic of Tanzania, Government policy is to encourage the use of fertilizers to increase tobacco production while slowing down shifting cultivation.

23. Livestock is also being introduced as an important land use in the miombo woodlands. For example, in the United Republic of Tanzania it is reported that about 36 per cent of total cattle in the country are in miombo-dominated areas. Nevertheless the density of livestock population in miombo woodlands seems to be higher than in other forested areas because former miombo woodlands, which are depleted, are still considered as miombo forest areas. This is the case of many parts of the Sukuma land around Lake Victoria. Moreover, in typical miombo woodlands, tsetse flies are still a serious problem. For instance, in Mozambique about 75 per cent of the total land area is still infested by tsetse fly, especially in the northern miombo formations. The figure for the United Republic of Tanzania is about 60 per cent. A similar trend is observed in Zambia in parts of eastern provinces (Chama and Lundazi districts), northern and north-western provinces (Kasempa and Chizera districts). In addition, the Forest Department's policies on grazing in miombo woodlands are not clear, sometimes they encourage grazing to reduce grass competition in young tree regrowth; but in other circumstances they discourage it because livestock can hinder regrowth. Grazing of the miombo stands has contributed to miombo degradation mainly through bush fires, but this issue would require further analysis in site-specific situations.

24. There is also increasing competition for land among different land uses. For example, valuable and high nectar-producing tree species are being cleared for tobacco farming as well as for tobacco curing. In some areas of the Tabora region, this has caused a decrease in honey and beeswax production.

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2/ $US 1 = 5.65 kwachas (September 1986).

Wood production and utilization

25. The roundwood production and utilization from the miombo forests is mainly in the form of woodfuel, poles, sawn timber and sleepers. The roundwood production between 1979 and 1984 is indicated in table 3 below. The importance of miombo as a source of timber supply is evident since it is estimated that more than 1.4 million, from a total of 2.5 million $m^3$ were exploited in the miombo woodlands of the subregion in 1985. Similarly, it is estimated that over 32 million $m^3$ of fuelwood and charcoal were produced in Tanzania's miombo woodlands in 1985, over 21 million $m^3$ in Mozambique and 8 million $m^3$ in Zambia during the same period.

Table 3. Indigenous roundwood production for all forests, 1979-1984

| Country | Year | Industrial | Fuelwood and charcoal | Total production |
|---|---|---|---|---|
| | | (in thousands of cubic metres) | | |
| Mozambique | 1979 | 903 | 11 200 | 12 103 |
| | 1980 | 933 | 11 880 | 12 813 |
| | 1981 | 1 028 | 12 200 | 13 228 |
| | 1982 | 934 | 12 900 | 13 834 |
| | 1983 | 923 | 13 300 | 14 223 |
| | 1984 | 923 | 13 500 | 14 423 |
| Tanzania | 1979 | 998 | 16 805 | 17 803 |
| | 1980 | 1 106 | 17 397 | 18 503 |
| | 1981 | 1 175 | 18 013 | 19 188 |
| | 1982 | 1 120 | 18 654 | 19 774 |
| | 1983 | 1 090 | 19 321 | 20 411 |
| | 1984 | 1 127 | 20 018 | 21 245 |
| Zambia | 1979 | 441 | 4 435 | 4 876 |
| | 1980 | 450 | 4 575 | 5 025 |
| | 1981 | 460 | 4 680 | 5 140 |
| | 1982 | 470 | 4 835 | 5 305 |
| | 1983 | 480 | 4 900 | 5 380 |
| | 1984 | 490 | 5 050 | 5 541 |

Source: FAO Yearbook of Forest Products, 1973-1984.

26. Production of industrial wood from the miombo forest is expected to decrease in most of the countries because the bulk of timber production comes from plantations and as a result of present rates of exploitation of valuable timber species that are impoverishing these resources. Nevertheless, consumption of fuelwood from miombo resources will continue rising, unless fast-growing village fuelwood lots, shelter-belts, wind-breaks and fuelwood plantations are established to meet urban and industrial energy requirements.

27. As already stated, little inventory has been done in these forests, accurate statistics are lacking, and most figures are based on estimates rather than fact. Official documents sometimes have to use estimated figures due to lack of information. The only reliable inventory figures were obtained from the United Republic of Tanzania because a forest inventory was done during the period 1978-1979, covering most of the commercial forest areas (544,075 ha), 89 per cent of which was in the miombo forests. The inventory showed that of 14.3 million cubic metres inventoried, more than 8 million $m^3$ were miombo resources, i.e., 57 per cent of the total inventoried volume. The average gross volume, therefore, was 25.9 cubic metres per hectare, a figure parallel with that mentioned in paragraph 7. Once again, the information on the volume actually harvested every year was not available.

28. Although there are many valuable species (e.g., 220 in Zambia and over 200 in Tanzania), only a handful are exploited for timber production, partly because of consumer preferences. These include Pterocarpus angolensis, Dalbergia melanoxylon, Swartzia madagascariensis, Milletia stuhlmanii, Brachystegia spiciformis, among other species. In view of this fact all the Governments have instituted policies and legislation to encourage the use of the lesser marketed species through, for example, differential stumpage and updating royalties.

29. The present royalty structure in the three countries theoretically encourages more utilization of the lesser marketed species. The royalty rates are higher for the more valuable and exploited species. In the United Republic of Tanzania, for instance, the royalty 3/ for Dalbergia and Diospyros is \$US 63.80/$m^3$ while that of Brachystegia spiciformis is \$US 6.30/$m^3$. The situation in Zambia is similar. The royalty for Pterocarpus angolensis is \$US 1.70/$m^3$, whereas that of typical miombo species is \$US 0.40/$m^3$. This trend applies also to Mozambique. In fact, the royalty policy in Mozambique also encourages local processing of the wood and in fact 91 per cent of the industrial roundwood harvested in 1985 was processed locally. This policy, of course, discourages the export of logs, but is in line with recommendations of the Lagos Plan of Action.

30. As a whole the royalties charged are dismally low and have little, if any, relation to market prices. For example, in the United Republic of Tanzania, a cubic metre of Pterocarpus angolensis sells at 5,000-8,000 shillings, equivalent to 116-186 US dollars (at \$US 1 = Tsh 43).

31. Another serious constraint in timber marketing and utilization is the inadequate licensing system and exploitation control presently used. The latter is partly justified by shortage of manpower. All three countries no longer use concession licensing system. They issue long- and short-term licences to exploiters in pre-marked cutting areas or in unmarked forests. A study of some licenses and exploitation figures have revealed that some unscrupulous exploiters sometimes take up to three times the permitted volumes. To make matters worse, the log volumes are sometimes measured in the sawmills rather than in the forests. Under extreme circumstances the Forest Departments determine original log volumes by converting sawn wood or sleeper volumes. The conclusion is evident - more wood is normally exploited than what the records show.

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3/ When the royalty was calculated at the rate of \$US 1 = Tsh 16.

32. The population in the miombo forests was 8 million in Mozambique, 7 million in Tanzania and 2 million in Zambia in 1985. In Mozambique, this represented 66.7 per cent of total population, while in Tanzania it was 23.2 per cent and in Zambia 29.3 per cent. This population is almost entirely dependent on fuelwood and charcoal for energy, with the per capita consumption ranging from 1.0 to 1.7 $m^3$/annum. A total of 61 million cubic metres of fuelwood is consumed in these areas, although some quantities of charcoal are transported to urban and suburban centres for sale. Certain regions are already facing fuelwood/charcoal deficit; for example, 5 regions out of 14 in the miombo areas in Tanzania have a deficit of 78 to 80 per cent. The others are progressing towards this situation. The dominance of fuelwood and charcoal is likely to continue even beyond the year 2000. The total wood consumption for these commodities will continue to represent 90-96 per cent between now and the year 2000. Estimates of fuelwood consumption indicate that about 140 million cubic metres will be consumed in the subregion, mainly from the miombo resources.

33. Unlike timber exploitation, charcoal is much more difficult to control particularly in the forests which are not legally reserved. The payment of a licence fee is used solely for transportation purposes. The fee has no relationship to the species, size and value of the trees felled, nor is it related to the efficiency of concession. Moreover, the market price is incredibly higher than the fee. In Ndola (Zambia), one 35-kg bag sells at approximately $US 2.50 whereas the fee per bag is K 0.9 (negligible in dollar terms). Similarly in Dar es Salaam (the United Republic of Tanzania), a bag of the same weight sells at about $US 4.70 while the fee per bag is $US 0.10. 4/

34. Charcoal production is a special problem in the unreserved miombo forests. In Zambia (1984), charcoal alone accounted for 86-89 per cent of total wood exploited in State and Trust lands dominated by miombo. This is partly because charcoal is also used in the mining industry. Charcoal making is now becoming a big threat to the miombo ecosystem. In Lusaka, the urban poor are also using charcoal burning as their sole mode of employment. Usually these "Manchonas" moved into town hoping for a better life. In the eastern part of Lusaka, charcoal burning is almost getting out of control. The Government, through the Ministry of Lands and Natural Resources in collaboration with the Ministry of Defence, is taking urgent measures to arrest the deforestation. The latter Ministry has some rights on the area (see annex IV). Similar trends have been observed in both Mozambique and the United Republic of Tanzania.

Beekeeping

35. Beekeeping is one of the most important land uses in the miombo woodland forests. About 60-70 per cent of the total beekeeping area falls within these forests. Beekeeping is almost entirely a household activity, but honey and beeswax processing and marketing are organized more on a co-operative basis. For example, villagers in Zambia produce about 70-80 per cent of total honey. It is also estimated that about 25 per cent of

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4/ $US 1 = Tsh 43.

the total population in the United Republic of Tanzania is involved in beekeeping, and the majority of these people keep their hives in the miombo forests. Most farmers use traditional beehives made of tree bark, especially from Julbernadia globoflora, Brachystegia spiciformis and Boehmii. The debarking is a threat to beekeeping. It kills the very trees which are the best nectar-producers; maybe 18,000-20,000 $m^3$ of potential timber species are lost through this practice.

36. As a whole, honey and beeswax production has increased since the 1960s, at least in Zambia and the United Republic of Tanzania where statistics are available, but there was an apparent decrease in the late 1970s and early 1980s, as indicated in annex VI. This trend may have been caused by:

(a) Growing competition for land and labour, e.g., in the tobacco-growing areas;

(b) Increasing transport costs from the production areas to the markets mainly organized by the forest departments;

(c) Poor markets and heavy foreign competition;

(d) Inadequate pricing system. For example, in Zambia the producer price for one kilogram of honey is $US 0.25, but the consumer price is $0.75. The consumers seem to be complaining that the price is higher than that of imported honey by nearly 35 per cent. The Government is reviewing the prices;

(e) Increased emigration of swarms from the miombo forests because of increased clearing, man-made fires, etc. There is also ample evidence that much honey production and consumption (particularly for local beer brewing) is unrecorded.

37. Forests, if adequately conserved, have a very high beekeeping potential which has not been fully explored. According to the Zambian Forest Department, honey and beeswax production potential is about 150,000 and 50,000 kg per annum respectively. Currently only 44 per cent and 15-20 per cent respectively of this potential is utilized. Moreover, most of this beeswax and honey would fetch a handsome amount of foreign exchange. The farmer could also benefit substantially. It is estimated that a family in the United Republic of Tanzania can harvest about 100-150 kg of honey and 40-60 kg of beeswax per annum; and an average family in the miombo forests can keep up to 150 beehives. During a good season and using current prices, a family can get $US 16.30 per hive, which is an income equivalent to about $US 2,442 per annum. There are, however, no farmers who are exclusively beekeepers, and so this income may be a bit higher than the actual situation.

38. Beekeeping in Mozambique is also important and the trends are generally similar. Unfortunately, not much data was available. Beekeeping is important not only as food and source of income for local communities but also for foreign exchange earnings. However, despite the low levels of investment required the industry seems to be on the decline in both the United Republic of Tanzania and Zambia.

Wildlife

39. The importance of wildlife in the subregion is indicated by the areas and percentage of land especially reserved for the purpose. Table 4 below gives the areas under different categories of wildlife management.

Table 4: Areas under wildlife management in Mozambique, the United Republic of Tanzania and Zambia (in thousands of hectares)

| Country | National parks | Game reserves | Game control areas | Special areas | National parks percentage of total land area |
|---|---|---|---|---|---|
| Mozambique | 15 850 | 19 400 | 56 700 | - | 20.2 |
| United Republic of Tanzania | 39 140 | 98 110 | 116 000 | 8 000 | 44.2 |
| Zambia | 6 600 | --- 10,000 --- | | | 30.5 |

40. In Mozambique there are a total of 4 national parks, 5 game reserves and 16 wildlife control areas. In Tanzania, there are 11 national parks, 18 game reserves, 50 game control areas and one special wildlife area. In Zambia, there are 19 national parks and 31 game management areas. Of the total areas under wildlife management, 70.0, 41.0 and 37.5 per cent are under miombo woodlands in Mozambique, Tanzania and Zambia respectively.

41. Wildlife management in all three countries is under the direct control of the respective wildlife departments, and wildlife is fully protected within the national parks, where harvesting is practised only by culling. Controlled harvesting and hunting are allowed in game reserves and game/wildlife control areas, and human habitation is allowed only in the latter. Licences are required both for subsistence and "safari" hunting.

42. The management problems are mainly those of shortage of manpower, funds and poaching. In Mozambique, the Wildlife Department is manned by only five qualified personnel. Since 1984, the Department has not been able to carry out any forest protection activities except in animal cropping in the Gorongosa National Park and Marromeu Game area through donor assistance. Poaching is a major problem in all the three countries. Commercial poaching is threatening the rhinoceros in all three countries.

43. The significance of game to the local communities is largely for the production of meat both from subsistence hunting outside the wildlife areas and from game cropping. Although figures are not available, it is estimated that 1,000 tons of game meat was sold to the local people in Mozambique in 1983. Similar figures can be expected from other tsetse-infested areas under miombo forests. Cropping of fast-reproducing animal species, like impala and buffalo, is carried out. It is also necessary to keep a balance between the number of elephants and the carrying capacity of the woodlands, as elephants have caused much damage in the Ruaha National Park in the United Republic of Tanzania.

44. Revenue realized mainly from hunting by tourists in Zambia between 1976 and 1980 ranged between K 0.90 million and K 1.2 million per year. Part of this was in foreign currency. Pilot schemes to ranch eland and puka have been carried out in Zambia. The potential of game ranching, especially in the tsetse-infested miombo areas, warrants closer investigation. A list of miombo wildlife species with potential for utilization is given in annex VIII.

45. Policies and legislation on wildlife conservation have been established, but their adequacy in the face of changing land-use patterns may be questioned. For example, expanding the agricultural use of chemicals and illegal hunting, among others, have a direct effect on the habitat and the wildlife species themselves. The issue of direct benefit by local communities and local authorities living in and around game areas also needs careful and positive examination.

Other land uses

46. Mushroom harvesting is an important activity in the miombo woodlands and they are a very important source of food, and more recently a source of income for the rural communities. Mushrooms are either cooked fresh or can be dried as emergency food for the dry season. The mushroom season coincides with the rainy season, e.g., December to March in Zambia when impromptu roadside markets sell many varieties. It is estimated that a farmer can get 20.00-30.00 kwachas per day selling mushrooms. Thus, assuming a good year and that only one member of the household collects mushrooms for 2 days per week (32 days in the season), a household could earn an additional income of 640-960 kwachas per season. Mushroom growth depends on the maintenance of suitable ecological conditions of the miombo woodlands, and adverse land-use practices may reduce or eliminate their existence.

47. A variety of fruit-tree species form part of the miombo forest formation such as Uapaca kirkiana, Anisophillea boehmii and Diospyros Kirkii Parinari and Curatellifolia. These also form an important part in the diets of local communities. Uapaca kirkiana fruit is one of the most popular in the region. In Zambia, it ripens between November and March and is sold by the roadside and in town markets. It is common to find these and other fruit trees growing amongst food crops, a sign of recognition by local farmers of their importance. Jams, jellies, relishes and beverages are obtained from a variety of miombo fruit trees. Research is being carried out in Kitwe, Zambia, in an effort to improve the silviculture and productivity of some of the fruit trees.

48. A number of caterpillar and cricket species are consumed in Zambia, Mozambique and Tanzania. They are a good source of protein and income for the local communities. The insects live on the leaves of some miombo species. The caterpillar Carima forda (Harati) belonging to the Emperor Moth Saturnidae family is a delicacy and has led to the destruction of the host tree Bakiae africanum which is cut down to obtain them. In the United Republic of Tanzania and Zambia, the caterpillar of Genera elaphrodes is also a popular food. More than 20 varieties of caterpillar are known to be edible in northern Zambia. They are also sold in markets in the copper belt. Today, one bag can fetch anything up to K 100.00. Like mushrooms, the survival of these insects depends on the existence of available tree species in the miombo forests, and their conservation.

## IV. FIRE IN THE MIOMBO WOODLANDS

49. Most of the miombo forests in the subregion are set afire every year. Most of these fires occur during the dry season from May to October. Unfortunately there are, at present, no studies to indicate frequency, extent, intensity and damage. A survey done by the Forest Department in the United Republic of Tanzania (1983) revealed the following:

| Month | No. of fires | Percentage of total in the season |
|---|---|---|
| September | 23 | 47 |
| October | 11 | 22 |
| August | 8 | 16 |
| July | 7 | 15 |
| Total | 49 | 100 |

There are also a few fires during the February-March dry spell. The survey also indicated that more than 17,000 ha were burnt between 1972 and 1983, 29 per cent of which were plantations. This area was in legally reserved forest alone. About 65,000-100,000 ha may be burnt every year in the country as a whole of which about 70,000 ha are miombo woodlands. In Mozambique, it is reported that over 50 per cent of total land area is burnt annually.

50. The causes of fire are generally similar in all the countries surveyed. However, there has been a tendency to report the same causes year in, year out, though also other causes have been important as well. The causes quoted most often are hunting for wildlife and honey, burning to induce new grass for livestock, and shifting cultivation. It has also been observed in Mozambique for example, that people travel on foot a lot in remote areas, and they normally "clear" bush in order to establish footpaths and have better visibility. A substantial area is burnt in the miombo woodlands as a local measure to control tsetse fly (Glossina spp.) when livestock is introduced and even afterwards. Charcoal burning is also a major cause of fires, especially where earth kilns are used. After the charcoaling is over, the burners frequently shift to another place without even attempting to extinguish the remaining fire. This is a particularly serious problem in Zambia. Lightning is also reported to be a significant cause in the copper belt in Zambia, but no information is available on the importance of this factor as a vector of fires.

51. The effects of man-made fires are well known. These range from destroying fauna and flora of the forests (especially damaging the young miombo regeneration growth) to increasing soil erosion by burning the accumulated forest organic matter.

52. Not much work has been done on the prevention of bush fires in the three countries visited mainly due to lack of trained personnel. Since the fires are mostly caused by the local communities, there is every reason to start with them in the search for preventive measures. Special fire campaigns are quite effective, especially through cinema shows in villages. Group meetings have also been valuable. The only problem is that once these periodic campaigns are over, there is little follow-up as to how effective they have been. There is currently enough legislation against bush fires, but in practice they are rarely followed. Consequently, this area needs revitalization and effective measures to prevent and combat shrub and forest fires. It is high time fires were given top priority in miombo and indigenous forests. Quite a bit has been done, on the other hand, in the plantations.

## V. THE SILVICULTURAL AND MANAGEMENT PRACTICES

53. At present there is little silvicultural management in the miombo forest. Management was relatively active during the 1960s to mid-1970s, but declined in the late 1970s and early 1980s. There are now signs that the "old" silvicultural and management practices are being revamped. The reason for the decline is not clear. It is possibly due to the fact that in the late 1960s and in the 1970s forest industries were expanding rapidly, and new wood products were coming in, requiring specialized wood. Fast-growing plantation species naturally offered a good option and research on the forest and individual species were directed towards plantation species. Policy-makers and some foresters have the mistaken idea that the indigenous forest resources were unlimited and that all one had to do was to harvest; financial resources became more scarce, as plantations were given relatively more attention.

54. The few agricultural and management activities carried out in these forests concentrated mainly on protecting forests from fire. Less attention was given to wood exploitation, logging, regeneration and miombo management systems. Burning is practised in all the countries, especially just before or at the start of the dry season. However, these fires are often not well controlled and cause more damage than benefits to the natural vegetation. In Mozambique and Zambia, forest fires are more frequent in May-June, and in Tanzania in June-July. The controlled or early burning helps to reduce grass biomass on the forest floor thus reducing the risk of fires during the dry season. It has also been reported that fire facilitates the germination of Pterocarpus angolensis and Brachystegia spp. seeds. Furthermore, controlled fire sometimes stimulates competition between grass in the undergrowth and young ligneous vegetation (see plates 1, 2 and 3), whilst late burning is more damaging to grasses. This has been confirmed in Mozambique and Zambia. In Kenya, Isoberlinia, Julbernardia and some Brachystegia spp. are known to be sensitive to late burning and man-made fires.

55. A form of miombo forest management carried out in most of these countries is selective harvesting. This system promotes the exploitation of valuable species, leaving the undesirable and crooked trees in the forest. This form of exploitation has made natural regeneration very difficult and in certain areas there are no seed trees whatsoever to favour regeneration of these species. Obviously, this practice leads to irreversible degradation of the miombo especially considering their low stocking per hectare (estimated

as 34 $m^3$ per hectare for the subregion as a whole). Moreover, if to this lack of silvicultural treatment are added the effects of over-exploitation [where in many cases the volume actually commercialized exceeds three times the annual allowable cut (AAC)], it is easy to understand why these forests have failed to attract investment in the subregion.

56. The main techniques used for encouraging regeneration are root suckers, seedlings and the coppice system. There have also been attempts to enrich degraded forests with faster growing indigenous or even exotic tree species. In the Ndola area of Zambia, it has been reported that root suckers are encouraged by human activities such as agriculture and charcoal burning. In short, at present there is very little silviculturally induced regeneration. Nature is left to take care of itself.

57. As pointed out above, work has again started to try to manage this important resource. In Mozambique, 10 trial plots were established in 1981 in the Marrupa area (Niassa Province) to assess the mean annual increments in typical miombo woodlands. Tentative results are shown in annex VII. The mean annual increment (MAI) range is 3-6 $m^3$/ha/annum. These data seem to be exceptionally high for the climatic conditions under consideration. The average figure for the miombo could range between 1-2 $m^3$/ha, as in Tanzania and Zambia, where the MAI is about 2 $m^3$/ha per annum. The figures for Mozambique refer to smaller areas and are still very tentative. Studies on natural regeneration are also starting. MAI studies are being carried out in the copper belt in Zambia and include natural regeneration by coppicing. No results are yet available. The United Republic of Tanzania is also involved in such research. Research aimed at the artificial regeneration of valuable species like Pterocarpus angolensis is being carried out at the Miombo Research Station in Tabora and in Lindi and Mtwara regions.

58. To reiterate, the miombo woodlands, like any other indigenous forests, can be well managed, silviculturally. The management techniques known could be applied to these forests, but the big question is whether the Governments are willing and will set aside enough resources to apply and improve the valuable silvicultural practices which were being used in the 1960s and 1970s.

## VI. INSTITUTIONAL ISSUES

59. The institutional issues focus mainly on policy, legislation, investment (finance, manpower development and allocation and infrastructure) and research.

### Policies and legislation

60. All the forest policies in the three countries have been reviewed since independence, in some cases more than once. To sum up, it can be said that there are still some weaknesses, particularly in regard to the exploitation and utilization of indigenous forests, especially the miombo forests. Moreover, some policies have omitted important subsectors which are now within the Forest Department Organization. For example, in Mozambique, wildlife is within the forestry sector, but it is not mentioned in the official forest directives. Furthermore, the question of the balance between fuelwood harvesting and the ecology of the natural forests is not adequately covered, for instance, in Tanzania. In addition, although manpower shortages

are critical, especially in Mozambique, training is mentioned just in passing. The Zambian policy's aim is "to provide opportunities for technical training for those engaged in forest work". It is evident that this statement would require further elaboration. That of the United Republic of Tanzania is more specific and it also includes the necessity to train the people so that they can fully participate in forestry. Finally, issues like research and agro-forestry are not clearly spelt out in most of the forestry statements of the subregion. The full text of the forest policies in the three countries is shown in annex V. However, problems are more pronounced in the implementation of these policies.

Investment in the miombo woodlands

61. There has been very meagre investment during the last decade in these forests although financial and manpower allocations are particularly needed. A lot of policy pronouncements do emphasize the importance of the miombo forests in the local and national economies. However, little gets achieved on the ground because resources allocated are not commensurate with the importance indigenous forests play in the economy of the region. In the United Republic of Tanzania, at the sectoral resources allocation level, only 1.95 per cent are assigned to forestry, wildlife, fisheries and tourism as indicated in Tanzania's Three Year Development Plan (see table 5). As can be seen from the table, natural resources which are an integral part of agriculture in the United Republic of Tanzania, had the lowest share.

Table 5. Development funds allocation in various sectors in the United Republic of Tanzania, 1976-1981

(in thousands of Tanzanian shillings)

| Sector | Amount allocated | Percentage of the total plan |
|---|---|---|
| Agriculture | 2 446 506 | 11.50 |
| Livestock a/ | 434 527 | 2.04 |
| Natural resources | 414 401 | 1.95 |
| Water | 1 448 778 | 6.81 |
| Power | 1 272 129 | 5.96 |
| Transport | 1 286 303 | 6.05 |
| Education | 1 688 506 | 7.94 |
| Health | 738 165 | 3.47 |
| Total for the whole plan b/ | 21 130 002 | 100.00 |

Source: Tanzania Bureau of Statistics.

a/ Includes forestry, wildlife, fisheries and tourism.

b/ Includes other sectors not shown.

62. The intra-sectoral apportioning of resources is similar. Let us take the example of Zambia. The funds for investment approved for the last five years are shown in table 6.

Table 6. Authorized development funds in Zambia from 1980 to 1984

(in thousands of Kwachas)

| Year | Total funds allocated | Percentage in industrial plantations | Percentage of indigenous forests | Percentage of Others |
|---|---|---|---|---|
| 1980 | 6 039 | 93.0 | 3.0 | 4.0 |
| 1981 | 7 034 | 79.0 | 2.0 | 19.0 |
| 1982 | 17 404 | 91.0 | - | 9.0 |
| 1983 | 3 015 | 39.0 | 0.3 | 63.7 |
| 1984 | 765 | 9.0 a/ | 38.0 b/ | 53.0 |

Source: Based on the 1980-1984 annual reports.

a/ Money spent only on Zambia teak.

b/ Included K 20,000 for beeswax processing project; but funds were not released.

63. It should also be noted that not all these funds were released. For instance, only 9.4 per cent of the total funds was released in 1984. This situation is likely to continue for the next five years. In the proposed Fourth National Development Plan financial investment in indigenous forests will also be about 12 per cent. In Mozambique, there has been no investment in wildlife since 1984.

Manpower development and allocation

64. Manpower is a scarce resource whose allocation in various sectors and subsectors needs scrutinizing. Again there seems to be too much emphasis on wood exploitation and processing, may be at the expense of silvicultural management of the forest resource, as exemplified in the current resource allocation in Mozambique, shown below:

| Activity | People employed In State Institutions (Number) | (Percentage) | In Private (Number) | (Percentage) |
|---|---|---|---|---|
| Logging, transport and processing | 12 470 | 66.4 | 2 140 | 100 |
| Reforestation | 5 220 | 27.8 | - | - |
| Conservation; national parks, etc. | 1 100 | 5.8 | - | - |
| Total | 18 790 | 100.0 | 2 140 | 100.0 |

Conservation and wildlife management get only 5.8 per cent of the total manpower while logging, transport (mainly from natural forests) and wood processing are allocated 66.4 per cent. This trend is likely to continue for the next five years. The level required for conservation and wildlife management would probably be of the same magnitude as that shown for reforestation.

Table 7. Manpower development and allocation in the forestry sector between 1985 and 2000

in Mozambique

| Subsector | 1985 | 1990 | 2000 |
|---|---|---|---|
| Silviculture | 1 990 | 2 125 | 2 350 |
| Harvest and transport | 4 220 | 5 080 | 7 800 |
| Mechanical industry | 4 100 | 5 200 | 6 200 |
| Total | 10 310 | 12 405 | 16 350 |

Source: Kir, A. (1984).

The above table indicates that silviculture (both in natural forests and plantations) will be allocated 19, 17 and 14 per cent of total manpower in 1985, 1990 and 2000 respectively while the corresponding percentages for harvesting and transport will probably be 41, 41 and 48 per cent for the same years.

65. The training facilities within these countries do not generally cope with manpower demands. Mozambique has a Faculty of Forestry in Eduardo Mondlane University, and there is a plan to start a new technical school. Zambia has the Mwekera Forestry College which trains on certificate and diploma levels. The College produces about 40 diploma graduates each year. The United Republic of Tanzania has a Faculty of Forestry at Sokoine University

of Agriculture in Morogoro where the output is about 20-30 undergraduates annually, while the annual turnover at the technical institute at Olmotonyi is about 50 diploma- and 120 certificate-holders. There is also a Forest Industries Training Institute at Moshi which offers both certificates and diplomas. Although accurate manpower requirement projections are not available, such projections are badly needed. Training does not meet manpower demand.

66. It is heartening to note that in addition to national efforts to improve and expand national training facilities, the subregion is already co-operating in this field. This Sokoine University of Agriculture and the Mweka Wildlife College in the United Republic of Tanzania are being used by both Zambia and Mozambique because such facilities do not exist in these latter countries.

67. It is clear from the above coverage that financial and manpower resources, as well as infrastructure and equipment, are mainly allocated to the forest harvesting, plantations, and wood processing. Little is invested in developing and management of the miombo resources which supply the bulk of the wood processed and utilized in the subregion. And there is evidence that this trend is likely to continue to the year 2000. Investing in plantations is essentially a rational policy. In most cases these plantations are already over-mature; and economic analysis shows that they can maintain themselves if adequate silviculture measures are provided. The problem is that the organizational set-ups are such that they do not often look at forestry as an enterprise. Much revenue is collected every year from these forests, but once the money gets into the national purse, very little is ploughed back to sustain the forests. There is therefore an urgent need to promote a policy of reinvestment of some percentage of revenue from these forests to strengthen their conservation and management. The need to reorient the organizational structures is an inescapable policy decision. Moreover, the tendency of according priority to more short-term income and foreign exchange-oriented activities needs review. It is also evident that most legislation is currently geared towards wood exploitation and little effort has so far been directed towards increasing the reserve forest estate as suggested by the Lagos Plan of Action.

Infrastructure development and communications

68. Infrastructure development and inadequate communications in the miombo woodlands are other policy implementation constraints. Poor infrastructure makes it difficult to control and monitor wood exploitation, fire, poaching, and so on. In Mozambique, for historical reasons, the rail and road network is from east to west. Moreover, communications between the provinces and the headquarters is a problem. For example, Maputo is over 1,440 km from the district forest offices near the Tanzanian border where the bulk of the miombo woodlands are situated. In Tanzania and Zambia the roads network in the miombo forests is very small.

Research

69. Here it suffices to reiterate that Research in the miombo forests is at its lowest level, and speedy measures are needed to reactivate this area. Moreover there has so far been little subregional co-operation in this domain. This should be fostered particularly among the forest research

institutions. Unfortunately such institutions do not exist in either Mozambique or Zambia where research is still done within the Forest Departments. The United Republic of Tanzania has an independent body, the Tanzania Forest Research Institute, which is under the umbrella of the Forest Division. The formation of such institutions will depend on the local situations. Priority research areas are further discussed in the following section.

## VII. CONCLUSIONS, RECOMMENDATIONS AND POSSIBLE PROGRAMME AREAS

70. It is clear that the importance accorded to the miombo forest resources, apart from their role as sources of fuelwood and timber, is minimal. Few programmes have been carried out in the fields of silviculture, management, identification of structure and floral composition, growing stock and assessment of non-wood resources, and little is known in these fields. The available information is based on rough estimates. On the other hand, degradation continues through such practices as shifting cultivation, man-made fires and other forms of exploitation. Investment both in finance and manpower is low.

Some critical issues requiring action are:

(a) The compilation of basic forestry data on the miombo woodlands to permit identification of priorities for forest inventories, particularly in the unreserved miombo forests and catchment areas;

(b) The conservation and rational utilization of fuelwood in areas of tobacco cultivation, especially in the United Republic of Tanzania and Zambia;

(c) Charcoal-making and its utilization at rural and suburban levels;

(d) The control and management of forest and bush fires;

(e) Training and applied research, with emphasis on techniques for regenerating and management of the miombo woodlands;

(f) The formulation of policies aimed at the exploitation of the miombo resources on the basis of its timber, fuelwood, charcoal and other non-woody resources;

(g) Investment in terms of finance of and manpower development in sustained yield forest management system.

71. Surveys and forest inventories should be undertaken at least in the following zones:

(a) The miombo forest state in the three countries;

(b) The miombo forests used for shifting cultivation, e.g., "Chitemene" and "tobacco farming" systems in the northern and Luapula provinces of Zambia and the Tabora region of the United Republic of Tanzania respectively;

(c) The formations considered essential for water harvesting and soil conservation, both at national and subregional levels.

72. The current trend to move from shifting to permanent cultivation systems is an activity that should be strongly encouraged through extension and experimental plots, demonstration of cash crop cultivation techniques, and agro-silviculture and livestock principles. In this context the use of fertilizers are available and appropriate farming inputs should be promoted.

73. There is an urgent need to establish a tree planting fund and forest management to protect the existing miombo stands, especially in the tobacco farming areas. This fund could be arranged and managed under the auspices of the Economic Commission for Africa (ECA) the Preferential Trade Area for Eastern and Southern Africa (PTA) or the Southern Africa Development Co-ordination Conference (SADCC). Governments of each country could contribute to develop this scheme through taxes on fuelwood.

74. Regarding timber exploitation, Governments could initiate studies with a view to raising the royalty in relation to market prices, bearing in mind that the sellers of wood products can in turn raise prices in response to the increased royalty. Another solution would be to limit the supply of high-value species, e.g. Pterocarpus angolensis, and Dalbergia melanoxylon. In addition, Governments should favour the creation of local co-operative sawmills in or near miombo woodlands and give incentives to those exploiting less marketable species.

75. There should also be tighter control on the harvesting of fuelwood, especially in the unreserved forests, through:

(a) Setting aside and managing fuelwood reserves;

(b) Relating charcoal exploitation to the yield capacity of the forest;

(c) Adjusting the licensing system for charcoal to correspond to the value and quantity of wood exploited;

(d) Slowing down deforestation by intensifying the current woodlot and plantation programmes;

(e) Making available an alternative of fuel resources to the urban population, especially expanding the use of kerosene and electrical energy.

76. Wildlife utilization not only benefits local communities but may also help its conservation. There is also a need to focus more attention on the poaching problem.

77. Efforts should be made to reserve the declining production and marketing of honey and beeswax, promoting the expansion of modern methods of production and processing.

78. An immediate subregional campaign against wild fires should be organized to supplement national efforts. The Economic Commission for Africa (ECA) and the Food and Agriculture Organization (FAO) should co-ordinate this campaign. The year 1988 should be declared as the year of combating wild fires in Africa.

79. Steps should be taken to train adequate and specialized manpower for managing and carrying out the necessary research in the miombo forests. Meanwhile a comprehensive investment plan to rehabilitate the miombo woodlands should be undertaken.

80. Finally, forest agencies should be reorganized so that plantations and industries become self-sufficient. This will enable governments to channel more financial resources into miombo woodlands and the indigenous forests as a whole.

## Possible programme elements

81. In order to implement these recommendations and bearing in mind FAO's Tropical Forestry Action Plan, the following programme elements should be considered. 5/

### The rehabilitation of the miombo woodlands

82. Most miombo woodlands are degraded and need immediate rehabilitation. Such a programme should include the conservation of the genetic resources, especially of the endangered species. As pointed out in this study, surveys and inventories of these forests are a prerequisite and the Regional Centre for Services in Surveying, Mapping and Remote Sensing in Nairobi, Kenya, could be of assistance in this respect.

83. Each country should increase the financial resources dedicated to the miombo woodlands by about 15-20 per cent annually at least up to the year 2000. Moreover the capability of the Forest Services should be strengthened to enable them to practise the necessary management plans for conservation and exploitation of these resources.

84. Only the United Republic of Tanzania has clearly spelt out the need to improve the miombo forests and increase village afforestation and agro-forestry efforts. The project is estimated to cost $US 30 million between 1987 and 1991. Such medium-term programmes should be initiated in Mozambique and Zambia.

85. A special programme combining charcoal production and the utilization of lesser marketed timber species should be started. This should also involve the adjustment of licensing and royalty procedures so that licences are issued to exploit these species in specified cutting areas in both reserved and unreserved forests. This will promote better utilization of less valuable species, and will contribute to conserving more valuable species.

86. The study of alternative sources of energy for village industries should be expanded. The possible use of solar energy, coal and electricity for tobacco curing should be analysed from the economic and technical points of view.

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5/ Is a plan concived by FAO in 1983 and endorsed by the twenty-third Session of the FAO Conference held in November 1985.

Non-wood products

Wildlife conservation and utilization

87. Special programmes should be initiated to improve the use of wildlife and processing of animal products, taking into account the large valuable potential of wild mammal species of miombo as well as to monitor population and distribution of mammals in relation to the carrying capacity of miombo woodlands. Anti-poaching operations are needed in all the countries, especially in relation to the rhinoceros, which is threatened with extinction.

88. Appropriate joint action on the trade of wildlife products should be pursued, taking into consideration the principles of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Regional and subregional co-operation is needed, especially where wildlife areas have common borders or are near each other, e.g., Niassa and Selous Game Reserves in Mozambique and the United Republic of Tanzania respectively, as well as the Tete region of Mozambique.

Beekeeping

89. Projects should be considered at both national and subregional levels. The thrust should be to help organize local communities to improve honey and beeswax production, processing and marketing. Moreover, Governments are called upon to:

(a) Assist the people to organize themselves into better production and processing units;

(b) Increase and improve buying centres;

(c) Update the producer price, which has generally been very low in relation to market prices; and

(d) Improve traditional techniques of beekeeping by promotion of modern beehives, e.g., top-bar hives.

Mushrooms

90. An immediate area to be considered should be the promotion of harvesting and marketing of mushrooms. This project has also been discussed by the SADCC countries.

Manpower development and research

91. A survey of manpower requirements for forest staff should be made in the subregion, at least up to the year 2000. The requirement should then be used as a basis for planning future training programmes. In addition, inter-university co-operation needs to be explored further and strengthened, especially to spread knowledge on the management and conservation of miombo resources among the countries of the region. Moreover, it would be necessary to start a miombo woodland applied research centre and a data bank. The proposal of such a centre has been discussed by the SADCC countries, but no concrete action has been taken so far.

Forest policy and legislation

92. National forest policies should specifically indicate the priorities required for the development, management and utilization of miombo forest resources and these priorities should be reviewed at least every five years Special chapters on management of timber resources, including the updating of timber royalties, beekeeping production and utilization as well as definition of agro-forestry and livestock systems, should be included.

Extension of the miombo woodland study

93. The present study should be extended to cover other countries which have substantial miombo forest resources, e.g., Angola, Zimbabwe, Malawi and Zaire. This would facilitate understanding of the entire miombo woodland ecosystem for future planning.

ANNEX I

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ANNEX II

TERMS OF REFERENCE OF THE STUDY

The role of silviculture and management principles in combating miombo woodlands degradation and depletion in African countries south of the equator

The terms of reference of the study are the following:

1. To carry out a detailed study to examine the present use of the woodland savannah in selected African countries south of the equator, emphasizing on the present forms of utilization of dry and humid miombo formations.

2. To assess the potential capacity of production of this ecosystem, appraising not only the importance of the wood products, but also those of non-wood products as fibre, gum, resin, fuelwood and honey among others, on the economy as a whole and on the rural population in particular.

3. To analyse the main causes influencing the miombo formations' depletion and degradation over the last 50 years, appraising the consequences of this disappearance and suggesting approaches for its conservation and expansion, including the existing policy framework related to the development and conservation of this subsector.

4. To study and review the traditional silviculture and management systems applied to the miombo formation, suggesting objectives and management methods through which this ecosystem could be invigorated.

5. To identify critical miombo forests, where selected projects could help in conserving and expanding them, at national and subregional levels.

6. Policy recommendations that could be adopted at national and inter-country levels to reverse current depletion of this forest cover.

ANNEX III

WORK PROGRAMME AND LIST OF PEOPLE MET

1. The report is compiled on the basis of data and information collected during the mission. This involved:

(i) Interviewing several people in the countries visited;

(ii) Questionnaire;

(iii) Use of documents and maps; and

(iv) Field visits where possible.

2. Itinerary of the mission

The itinerary of the mission and the list of people met are given below:

| | |
|---|---|
| 31-8-86 - 1-9-86 | - Briefing in Addis Ababa |
| | - Departure from Addis Ababa, arrival in Dar es Salaam. |
| | - Visit to Forest and Beekeeping Division |
| | - Visit to Wildlife Division |
| | - Visit to Institute of Resource Assessment, University of Dar es Salaam |
| 6-9-86 | - Departure Dar es Salaam, arrival at Morogoro and field |
| | - Visit to the Faculty of Forestry, Sokoine University of Agriculture |
| | - Departure by road to Dar es Salaam |
| 8-9-86 | - Visit Department of Geography, University of Dar es Salaam |
| 9-9-86 | - Depart Dar es Salaam, arrive Maputo by air |
| 10-9-86 | - Visit UNDP and FAO |
| | - Visit the National Agricultural Research Institute |
| | - Visit Directorate of Forestry |
| 11-9-86 | - Depart Maputo, arrive Lusaka by air |

| | |
|---|---|
| 12-9-86 | - Visit ECA Lusaka office |
| | - Visit Ministry of Lands and Natural Resources |
| | - Depart Lusaka, arrive Ndola by air |
| 13-9-86 | - Depart Ndola, arrive Kitwe by road and field |
| | - Visit Forest Department, Division of Research and Field |
| | - Depart Kitwe, arrive Ndola by road |
| 15-9-86 | - Visit Forest Department, Headquarters and field |
| | - Depart Ndola, arrive Lusaka by air |
| 16-9-86 | - Depart Lusaka, arrive Dar es Salaam by air |
| 17-9-86 | - Depart Dar es Salaam, arrive Addis Ababa by air |
| 17-9-86 - 2-10-86 | - Report writing and debriefing at Addis Ababa. |

3. List of people met

United Republic of Tanzania

| | |
|---|---|
| P.E. Kimariyo | Acting Director of Forestry and Beekeeping |
| E.J. Mlowe | Senior Forest Officer, Resource Assessment Subdivision |
| B.S. Kessy | Senior Forest Research Officer, and Forest Research Co-ordinator |
| D.Kihwele | Senior Beekeeping Officer in charge of Beekeeping Subdivision |
| S.B. Mbwana | Senior Forest Officer, Resource Development and Management |
| B. Midala | Wildlife Division |
| Prof. A.B. Temu | Dean, Faculty of Forestry, Sokoine University of Agriculture |
| Prof. J. Maghembe | Head of Biology Department, Sokoine University of Agriculture |
| Prof. J.P. Msangi | Head of Geography Department, University of Dar es Salaam |
| S.B. Kikula | Research Fellow, Institute of Resource Assessment |

Mozambique

| | |
|---|---|
| A. Kir | Forest Economist |
| F. Costa | Senior Forest Officer |
| L. Melamari | Wildlife Ecologist |
| M.S. Chambal | Technical Officer |
| R. Zoltto | Technical Officer |
| J.M. Shoelen | National Agricultural Research Institute |

Zambia

| | |
|---|---|
| S. Meke | Deputy Chief Conservator of Forests |
| I. Musokotwane | Conservator of Forests, Research and Beekeeping |
| S.M. Chisumba | Senior Forester, Botany and Ecology. |

ANNEX IV

ILLEGAL CHARCOAL BURNERS IN ZAMBIA

"Illegal charcoal burners get the boot*

Government is to take urgent steps to arrest deforestation caused by illegal charcoal burners and 300 squatters on the Lusaka East local forest number F-27.

The Ministries of Defence and Lands and Natural Resources are to embark on a joint operation to remove the charcoal burners and squatters out of the forest which has been declared as a military zone.

Defence Minister General Malimba Masheke and his Lands and Natural Resources counterpart Mr. Ben Kakoma said on Thursday that vast areas of the forest which forms about 4 per cent of Lusaka area had been devastated by bush fires made by the charcoal burners.

Most of the trees have been reduced to stumps while others have been felled in readiness for charcoal burning which residents from Bauleni township and other nearby areas are engaged in.

The squatters whose shacks were burnt down by the ministers and their team denied they were engaged in charcoal burning but said the illegal practice was being carried out by people from Bauleni.

An official from the forestry department who was in the entourage said the charcoal burners sneaked into the area in the early hours of the day and late in the evening when they are not likely to be caught because most of them have no licences.

Mr. Kakoma appealed to police to set up road-blocks and demand licences from any charcoal burner coming from the forestry.

Gen. Masheke ordered the squatters to leave the place and said he would deploy military personnel to protect the area. - Zana."

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* Extract from the Times of Zambia, Saturday, 13 September 1986.

ANNEX V

EXTRACTS OF NATIONAL FORESTRY POLICIES IN MOZAMBIQUE, TANZANIA AND ZAMBIA

A

EXTRACTS FROM THE ECONOMIC DIRECTIVES OF THE THIRD CONGRESS OF FRELIMO*

In the forestry sector we must develop forces with a view to proceeding to the following actions:

1. Forestry reconnaissance of the country by carrying out forestry inventories in areas selected for their recognized forestry potential.

2. Promotion of the forest economy through the organization and control of the exploitation of more valuable species which should be reserved for export, and developing the extraction of less valuable species, disseminating information of their proper utilization.

3. Establishing areas of forest regeneration to assure continuity of the country's forest resources.

4. Control of forest exploitation in zones where restricted fellings might accentuate erosion, leading to soil degradation and silted rivers.

5. Promotion of natural regeneration or protective afforestations in denuded areas where erosion is becoming critical, especially of the coastal dunes and in the Angonia region, and control of feelings in zones where the danger of erosion is present.

6. Establishment of forestry centres, notably in the communal villages, designed to facilitate the supply of wood products to local populations and to valorize neighbouring natural forests.

7. Development of plantations of fast-growing species, e.g. eucalyptus, near the urban centres, with priority to the city of Maputo, to supply the urban population with fuelwood and charcoal.

8. Expanding plantations, especially in Manica Province, of fast-growing species, e.g. eucalyptus and tropical pines, to provide raw material for particle board, pulp, paper and board industries.

9. Carry out studies for, and if possible establish, popular plantations in suitable areas of Maputo and Gaza provinces to provide raw material for the match industry.

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*Extract from Ferreira de Castro Forest Resources in Mozambique and their Rational Use, FAO, Rome, 1978.

5

"1.0 TANZANIA FOREST POLICY

In order to minimize these shortcomings the following policy is proposed:

1.1 General forest development

1.1.1 To demarcate and reserve in perpetuity for the benefit of the nation forested land or land capable of afforestation to preserve or improve local climates and water balance (supply), stabilize land which is liable to deterioration and provide sustained yield of forest produce for local and export markets.

1.1.2 To manage and develop state forests, state-controlled forests (public lands), village and private forests in order to perpetuate the values and benefits of the same;

1.1.3 To set aside forested areas for scientific purposes;

1.1.4 To set aside forest areas for recreation and amenity purposes.

1.2 Development and management of natural forests

1.2.1 To preserve, develop and manage both public and state-owned natural forests;

1.2.2 To ensure that catchment forests are properly preserved and managed in perpetuity to ensure a sustained supply of water, conservation of soil, flora and fauna and amelioration of climate.

1.3 Afforestation and reforestation

1.3.1 To ensure that urban and rural communities and various authorities establish and manage forest woodlots and plantations for fuelwood and charcoal, including other wood energy sources;

1.3.2 To establish sufficient forest plantations in suitable areas to create enough forest produce for the home and export markets;

1.3.3 To encourage and advise the integration of forestry with related sectors in order to capitalize on the role of forests in the development of the national economy.

1.4 Extension services

1.4.1 To advance knowledge and understanding (general public awareness) among the people of this country on the values and benefits of forestry to them and to their descendants;

1.4.2 To provide training to villagers and other institutions on all aspects of forestry especially on rational utilization of forests and its products.

1.5 Industry

1.5.1 To formulate and co-ordinate a forest industrial strategy for the rational utilization of forest resources;

1.5.2 To encourage and support efficient use of the forest resources in the establishment of forest-based industries on the basis of sound feasibility studies;

1.5.3 To promote the use of lesser marketed indigenous tree species and locally grown exotic species for general utility purposes, and thus make available valuable indigenous wood for specialized uses and for export;

1.5.4 To establish sufficient wood industries and improve infrastructural facilities within the existing plantations in order to increase the utilization for both local consumption and export;

1.5.5 To set rules and grades governing the local use and export of all forest products.

1.6 Protection

1.6.1 To protect forest against fires, diseases, pests, adverse elements of weather and man.

1.7 Resource assessment, research and training

1.7.1 To conduct forest resources assessment with a view to have up-to-date information on resources availability and its quality;

1.7.2 To undertake and intensify applied research in all branches of forestry and disseminate research findings to the public;

1.7.3 To liaise with other related sectors on promoting research on the use of wood as a source of energy;

1.7.4 To provide training to forestry personnel at all levels in the development, management and utilization of the forests and its products.

1.8 Employment

1.8.1 To organize and offer employment in the forestry sector by encouraging the use of labour-intensive methods provided they are economically viable;

1.8.2 To promote forestry as source of employment in the rural communities.

2.0 The beekeeping policy has the following objectives: 1/

2.1 Beekeeping development and management

2.1.1 To encourage the establishment and development of large-scale apiaries in areas with high beekeeping potential for the production of sufficient bee products for the local market and a surplus for export;

2.1.2 To encourage and advise public institutions and the private sector to promote the beekeeping industry;

2.1.3 To encourage the establishment and development of beekeepers' co-operatives and other groups;

2.1.4 To integrate beekeeping activities with other related sectors in order to increase both agricultural production and other values of economic importance through pollination services rendered by bees.

2.2 Development and consolidation of marketing

2.2.1 To set quality standards for the bee products and ensure that their marketing is carried out in accordance with the set rules and regulations;

2.2.2 To advise and encourage the public to use more honey as food;

2.2.3 To establish a legal system which will develop and promote both local and export marketing systems of bee products.

2.3 Establishment and development of bee reserves

2.3.1 To demarcate enough forests and woodlands suitable for bee conservation. These areas will be gazetted and reserved by law to conserve bees for the benefits of present and future generations;

2.3.2 To co-operate with both the Forestry and Wildlife sectors so that rational beekeeping activities can be carried out in Forest and Wildlife Reserves;

2.3.3 To collaborate with forestry and agricultural sectors in implementing agro-forestry-apiculture programmes;

2.3.4 To promote public participation in the protection of these reserves.

2.4 Training and extension services

2.4.1 To provide basic training to the beekeeping personnel;

2.4.2 To develop high-level manpower training programmes for the beekeeping industry;

2.4.3 To disseminate appropriate beekeeping technology with more emphasis to small-scale beekeepers;

2.4.4 Public institutions such as District Council and Co-operatives will be encouraged to offer services to the beekeepers as regards transport for beekeeping equipments, inputs and bee products.

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1/ Before the end of 1985 the beekeeping sector existed as a full Directorate.

2.5 Research development

2.5.1 To carry out applied research on the beekeeping industry;

2.5.2 To carry out periodic resource assessment for the development of the beekeeping industry;

2.5.3 To foster co-operation with national and international institutions which deal with apicultural research and other related fields."

C

ZAMBIA'S NATIONAL FOREST POLICY

"To carry out in each district forest surveys and to determine the forest resources for each district, the forest areas needed to be managed for land protection and for local and industrial supplies of forest produce, and the forest plantations which are needed, so that the forest estate required can be put under Government control.

To carry out all necessary research work on the ecology, protection, management and restocking of indigenous forest areas; on the establishment, protection and management of plantations and on the protective role of forests.

To carry out all necessary research on the exploitation of indigenous and plantation timber, on the properties, seasoning, sawmilling, preservation and working qualities of these timbers and, in co-operation with other interested organizations, to carry out necessary research and development work on timber engineering and on supplies for wood-based industries.

To provide tree seed for the Republic's plantations by the establishment of seed stands and seed orchards and by collection and purchase.

To place under Government control sufficient forest areas in each district to supply the forest produce required for people's homes, farms and local industries, and to provide for the proper management of these forest areas.

To place under Government control land for forest plantations needed to provide forest produce for people's homes, farms and local industries in districts where indigenous forest areas are unable to meet local needs, and to establish and manage these plantations.

To place under Government control and to manage those forest areas needed to supply the Republic's industries with their requirements of indigenous timber and, where possible, to supply timber for export.

To place under Government control land for forest plantations needed to supply the Republic's industries with their requirements of plantation timber, and to establish and manage these plantations.

To make arrangements for the cutting and marketing of indigenous and plantation timber.

To supply indigenous and plantations timber for industrial and local needs at an economic price.

To place under Government control and to manage forest areas needed to protect the land against floods, erosion and desiccation and to maintain the flow of rivers.

To integrate the Republic's forest areas and plantations in a wise system of land use, and to co-operate with other organizations in the development and protection of the Republic's natural resources.

To provide an extension service in beekeeping and in the production of beeswax and honey based on research and development work on beekeeping under Zambian conditions.

To advise and encourage local authorities, interested organizations and private persons in the practice of sound forestry.

To spread among the people of Zambia an understanding of forestry.

To provide opportunities for technical training for those engaged in forest work."

ANNEX VI

HONEY AND BEESWAX PRODUCTION
(in thousands of kilograms)

A. United Republic of Tanzania

| Year/Period | Honey | Beeswax |
|---|---|---|
| 1906-1915 | 51 075 | 5 023 |
| 1916-1925 | 38 715 | 3 874 |
| 1926-1935 | 67 605 | 6 762 |
| 1936-1945 | 89 100 | 8 911 |
| 1946-1955 | 81 630 | 8 187 |
| 1956-1965 | 76 065 | 7 600 |
| 1966-1975 | 60 405 | 6 011 |
| 1976-1981 | 26 532 | 2 650 |
| Total | 491 327 | 49 018 |

Source: Forest and Beekeeping Division.

B. Zambia

| Year | Honey | Beeswax |
|---|---|---|
| 1963 a/ | - | 10 500 |
| 1964 | - | 62 200 |
| 1965 | - | 24 400 |
| 1966 | - | 37 700 |
| 1967 | - | 50 800 |
| 1968 | 461 | 27 700 |
| 1969 | 825 | 19 800 |
| 1970 | 2 000 | 21 066 |
| 1971 | 1 661 | 9 007 |
| 1972 | 4 544 | 16 814 |
| 1973 | 6 296 | 21 085 |
| 1974 | 3 668 | 10 974 |
| 1975 | 19 682 | 6 025 |
| 1976 | 9 510 | 17 682 |
| 1977 | 27 360 | 26 088 |
| 1978 | 19 576 | 14 753 |
| 1979 | 15 560 | 17 975 |
| 1980 | 22 293 | 9 073 |
| 1981 | 93 900 | 13 461 |
| 1982 | 80 600 | 20 761 |
| 1983 | 66 158 | 9 210 |
| Total | 374 614 | 445 674 |

Source: Forest Department.

a/ It is not clear why there was beeswax production without that

Note:

1. To produce 1 kg of beeswax approximately 10 kg of honeycombs are needed. The above figures, for example 1983, do not follow this ratio. May be much of the honey was consumed locally, and the farmers did not bother to produce beeswax.

2. Although there have been fluctuations in beeswax production for the last eight decades, there has been a decline during the period 1976-1981 in Tanzania and during 1982-1983 in Zambia. This trend applies also to honey and beeswax exports.

3. It has been observed that a substantial amount of honey (and even beeswax) is not recorded - much of it is "traded" and consumed locally. So these figures may not give a complete picture.

MION

| Plot No. | Plot size (ha) | No. of trees above 10 cm Dbh | No. of trees above 20 cm Dbh | M |
|---|---|---|---|---|
| 1 | 0.25 | 70 | 36 | |
| 2 | 0.25 | 61 | 34 | |
| 3 | 0.25 | 75 | 30 | |
| 4 | 0.25 | 81 | 34 | |
| 5 | 0.25 | 64 | 47 | |
| 6 | 0.25 | 41 | 21 | |
| 7 | 0.25 | 79 | 25 | |
| 8 | 0.25 | 67 | 23 | |
| 9 | 0.25 | 84 | 18 | |
| 10 | 0.25 | 97 | 24 | |

Note: Plots 1, 3, 5, 7 and 9 are burnt every year, whilst plots 2, 4,

ANNEX VII

BO FOREST INVENTORY IN MOZAMBIQUE

| n height (m) | Losses in the Mean annual increment ($m^3$) | Losses 2-year period (dead trees) | Clearly resulting from fire |
|---|---|---|---|
| 15.9 | 6.16 | 5 | 2 |
| 15.2 | 6.17 | 2 | - |
| 14.3 | 3.36 | 3 | - |
| 13.1 | 3.47 | - | - |
| 12.3 | 5.51 | 2 | - |
| 12.7 | 2.58 | - | - |
| 9.3 | 2.99 | - | - |
| 9.5 | 3.03 | 1 | - |
| 9.0 | 3.78 | - | - |
| 9.9 | 2.80 | 1 | - |

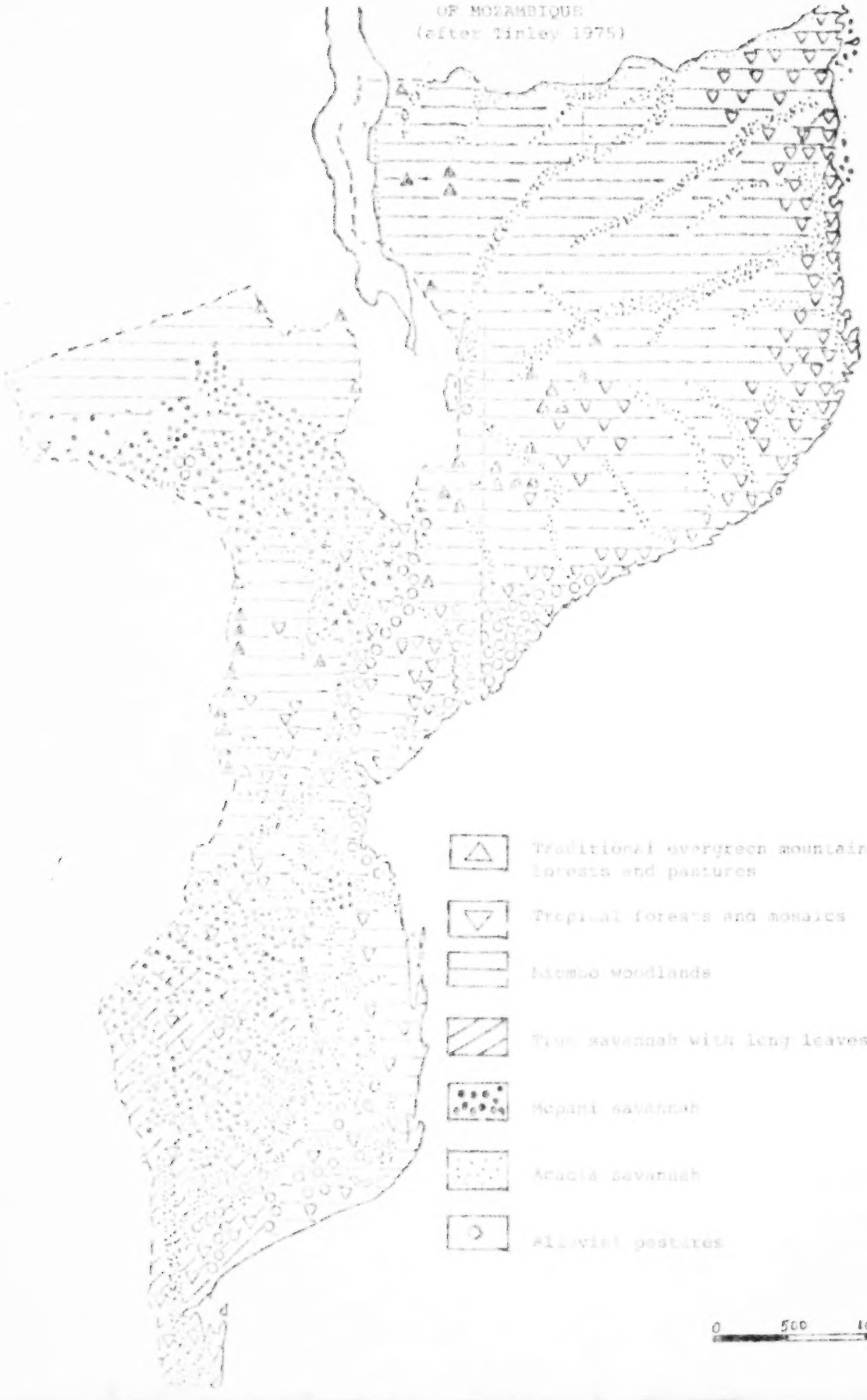
, 8 and 10 are strictly protected from fire.

# ANNEX VIII

## LARGE WILD MAMMAL SPECIES OF MIOMBO AND ASSOCIATED VEGETATION TYPES, WITH POTENTIAL FOR UTILIZATION

| | |
|---|---|
| Greater Kudu | *Tragelaphus strepsiceros* |
| Bushbuck | *T. scriptus* |
| Eland | *Taurotragus oryx* |
| Buffalo | *Syncerus caffer* |
| Bush Duiker | *Sylvicapra grimmia* |
| Waterbuck | *Kobus ellipsiprymnus* |
| Lechwe | *K. leche* |
| Puku | *K. vardoni* |
| Reedbuck | *Redunca arundinum* |
| Roan antelope | *Hippotragus equinus* |
| Sable antelope | *H. niger* |
| Wildebeest | *Connochaetes taurinus* |
| Lichtenstein's Hartebeest | *Alcelaphus lichtensteini* |
| Impala | *Aepyceros melampus* |
| Warthog | *Phacochoerus aethiopicus* |
| Hippopotamus | *Hippopotamus amphibius* |
| Elephant | *Loxodonta africana* |
| Zebra | *Equus burchelli* |

MAP 1
THE VEGETATION TYPES
OF MOZAMBIQUE
(after Tinley 1975)



MAP 2
MIOMBO WOODLAND DISTRIBUTION IN
THE UNITED REPUBLIC OF TANZANIA
(after Gillman 1949)

MAP 3
MIOMBO WOODLAND DISTRIBUTION IN ZAMBIA
(after Fanshawe 1969)

KEY

| | |
|---|---|
| | KALAHARI SAND VEGETATION |
| | FLOOD PLAIN GRASSLAND |
| | EVERGREEN FOREST |
| | MOPANE/ACACIA WOODLAND |
| | MIOMBO WOODLAND |

PLATE 1. THE EFFECT OF FIRE ON REGENERATION OF BRACHYSTEGIA AND JULBERNARDIA SPP. IN NORTHERN MOZAMBIQUE

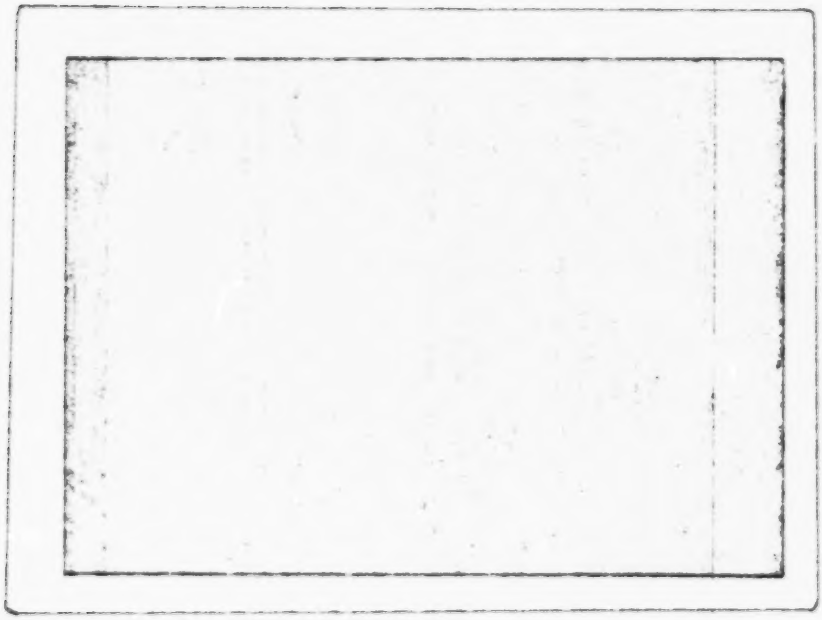


PLATE 2. [illegible] REGENERATION 36 YEARS AFTER [illegible] CULTIVATION, EL [illegible] MEXICO